

XI. *Notes on the Taxonomic value of Genital Armature in Lepidoptera.* By G. T. BETHUNE-BAKER, F.L.S., F.Z.S.

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PLATES LV-LXV

IN that valuable contribution to our knowledge of these organs in Coleoptera by Dr. Sharp and Mr. Muir (Trans. Ent. Soc., 1912, pp. 477 *et seq.*) the following sentence occurs on page 613 :—

“It has been supposed that the copulatory structures are bad guides in classification, although they are generally admitted to be of the first importance for the discrimination of species. If, however, the extreme importance of the genital conduit be seized, it will appear that its structure must certainly be of very great assistance in taxonomy.”

Inasmuch as these organs in *Lepidoptera* are not altogether similar to those in the group that were being dealt with in that able memoir, I would substitute for “genital conduit” “sexual armature,” and then I would adopt the whole paragraph for my own purpose. I am led to do this for two reasons, the first because there are still eminent systematists among us who for all practical purposes have no belief in the value of these organs, whilst the second reason is that extended investigation of these structures in *Lepidoptera* has convinced me that they are of very great value in taxonomy as well as in phylogeny. Of recent years my researches have gone much further afield than five-and-twenty years ago when I first began this branch of work, and the more I have seen the more do I feel the value of them for the systematist from every point of view. It appears to me that they are necessary characters not only in the discrimination of species but of genera also; I do not say that they are infallible in every genus—there may be, indeed we should expect there would be, exceptions. We consider neuration to be—shall I say—absolutely necessary for correct generic classification, yet there are genera where it is quite unstable, but that fact does not at all impinge on the value of that character for general

classificatory purposes, so it is with the sexual armature of *Lepidoptera*, and my desire is, in this paper, to lay before my fellow systematists, at least those of them who are sceptics on this point, some facts illustrated by figures to enable them to see that there is very much more value to be found in these organs than they have hitherto been willing to admit.

I will begin my evidence with that group of the *Rhopalocera* that I have made my special study—the *Ruralidae*, *i. e.* the *Lycaenidae*, Auct., but it will of course be necessary to consider other families as well. I will first compare *Plebeius argus*, L., and *Polyommatus icarus*, Roth.; if the figures are compared it will be seen that the clasps, Pl. LV, fig. 1, of *argus* are much broader than those of *icarus*, Pl. LV, fig. 2; that the aedoeagus, Pl. LV, fig. 1, of *argus* is much larger (especially longer) than that of *icarus* and is quite a different shape, and that the laterals of the tegumen in *argus*, Pl. LV, fig. 1, are decidedly slighter than those of *icarus*, Pl. LV, fig. 2. Now these are not specific variations; there is a considerable section of Staudinger's "omnibus genus" *Lycaena* that follows the general "build" or form of the armature of *argus*, and there is another considerable section that follows the general build of *icarus*.

The question then arose, Is there any other character confirming their separation, inasmuch as the neuration is practically the same? This character is forthcoming, the eyes of the *argus* group, *i. e.* the genus *Plebeius*, are glabrous, whilst the eyes of the *icarus* group, *i. e.* the genus *Polyommatus*, are hairy. I am aware that certain workers, even of my personal friends, would disregard this character, but I cannot follow them; the character persists in each genus and it does not seem to me to be reasonable to ignore it, especially when it is a confirming point. Over twenty years ago in these Transactions (1892, p. 27) I was induced by these characters to remove *tengstroemi* and its allies from that same "omnibus genus" *Lycaena* to another almost equally "omnibus" genus *Thecla*, since when de Nicéville has created another genus for that little group, *viz.* *Neolycaena*, naming for its type *sinensis*, Alph. Staudinger and I think nearly all others have accepted the transference without a question.

The genus *Habrodias* was created by Scudder in 1876 (Bull. Buff. Soc., iii, p. 136) for *grunus*. The male armature was not taken into consideration, the neu-

ration differs from its near allies, whilst the genitalia abundantly justify its separation, the sternite and the tergite sections being very unusual in structure (for *Ruralidae*); the clasps are composed of an ovate portion, truncated at the front apex and angled off at the lower part, it is open fore and aft but closed above and below and on each side are the clasps proper, somewhat ham-shaped with the knuckle end bent slightly downwards, both portions are very sparingly supplied with fine bristles. The aedoeagus is very large (this organ is an important item in *generic* differentiation), shortish, for its family, but very wide, tapering somewhat for the basal four-fifths, where it is obtusely angled, from whence the apex expands into a large florescent trumpet-shaped orifice. The girdle is erect, expanding suddenly forwards below the tegumen, which is funnel-shaped, deeply excavated in front with the dorsum terminating in a blunt point. Whilst the lower part is bifid also terminating in blunt points, below these are the falces broad and strong, suddenly curved upwards near their tips with one or two sharp teeth near the bend; the apices of the lower part of the tegumen are furnished plentifully with bristles, but the dorsum very sparingly. The genus *Hypaurotis* was separated off—again by Scudder (*l.c.*, p. 112)—on what I thought were very fine grounds for the species *Chrysalus*, but having examined the armature I do not think copulation would be likely to take place with species even within its own family. The clasps are quite different in shape to any other American species or any near ally, and the aedoeagus is very peculiar; it is bottle-shaped in its tubular section, tapering wider up to its terminal third, where it is suddenly constricted like the neck of a wine bottle, expanding but slightly at its apex—about as much proportionately as a champagne cork does. The tegumen, however (again a very important generic character), is perhaps the most specialised, the dorsum is broad and ample, the front apex being very highly excavated, the two laterals being reduced to two long deeply curved strong hooks, the front edge below the hooks being deeply excavated also and produced downwards into a lobe at the bottom of which the falces are attached and are very unusual, they are strongly curved upwards from the base where they are very broad and strong, their upper or dorsal part being broadly covered with strong sharp teeth extending along up to the point where they are sharply

recurved, this recurving being much finer and tapering downwards to the apex. The girdle is bent forwards, not erect, and has a broad lobe directly behind the lobed portion of the tegumen.

Two other allied genera *Ialmenus* and *Pseudalmenus* are very close to each other, but their separation is quite justified by the armature; in the former, *Ialmenus evagorus*, the tegumen is hood-shaped and all in front; in the latter, *Pseudalmenus myrsilus*, it is very largely truncated in front with a considerable backward projection, whilst the clasps are formed absolutely diversely in their whole character. On this latter point it should always be borne in mind that clasps may differ and show merely specific differences, but a total change in form and outline, whilst of secondary taxonomic importance to the tegumen, yet has a real value when taken with other details.

In the *Gerydinae* the male armature at once shows marked generic differentiation. In this group is found a complete inversion of the usual characters. In *Gerydus leos* and all other species of the genus the clasps are relatively quite insignificant, not that this has been developed so much by a reduction in size of these organs (though in comparison with other families they are rather small), but by the immense development of the tegumen; this section of the armature is very unusual, the dorsal bridge is reduced to an extremely narrow ridge, whilst the two lateral cheeks or lobes are produced and enlarged into two long razor-shaped blades that when withdrawn into the abdomen occupy more than two-thirds of the abdominal length; the falces or hooks are placed beyond the middle of the blades rather nearer the apex, they are long and strong with a sharp robust S hook at their extremity, their action is secured by a strong chitinous muscular attachment with the front apex of the blade which is specially strengthened for this purpose. The aedoeagus is a short plain tube, tapering to a fine point, the orifice extending backwards for nearly half its length and partaking of the taper already referred to, the clasps are small and shortish somewhat boat-shaped tapering to a blunt point, with the upper apical edge densely fringed with long hairs for nearly half its length, with a patch of hairs on its lower part also. The internal area of the blades of the tegumen is likewise clothed thickly with soft hairs. The African genus *Megalopalpus* belongs to this family and not to the

*Lipteninae* with which it has generally been placed. The armature proved this conclusively. The same great development of the tegumen has taken place, though in this genus the tegumen is wedge-shaped with the lower fore edges well excavated and curved, thus ending in fine points; the falcies are quite different, being of the usual Ruralid shape. Both the aedoeagus and the clasps differ from *Gerydus* though they are of equally simple form, both are, however, rather longer, though slighter. It is quite evident, however, that the genus belongs to the sub-family *Gerydinae*. Let me take another section of the same great order, and let us consider one or two examples from among the *Lipteninae*. The genus *Pentila* needs a good deal of revision; I will take two species out of that genus as it stands in "Rhopalocera Aethiopica," viz. *muhata* and *abraxas*, Hew. In many respects the armature of the former reminds me of that of the *Hepialidae*; it seems to have an additional pair of clasps in the centre of the girdle. As a general rule the tegumen is in the tergite and the clasp in the sternite sections of the abdomen (and we thus have the anal orifice quite distinctly separated from the genital orifice), these being united by the girdle, which in a sense completely amalgamates the tergite and sternite. In *muhata*, however, it would almost appear as if a pair of clasps had been developed at the base of the tergite, as well as in the sternite; to grasp the point fully it is almost necessary to refer to the figure, where it is seen that the tegumen has a slight hood with two long robust arms that are well provided with long strong bristles; below these jointed to the girdle (which in this species is not a simple collar of chitine but is definitely divided near the middle), but still in the tergite, are two broad arms highly excavated at the apex and strongly hooked; they are provided with fine longish bristles. The sternite section of the girdle is attached to the base of the tergite section (Pl. LVIII, fig. 10) and forms quite a distinct section (with the clasps and aedoeagus), though it is jointed on to the tergite portion; the girdle is highly concave and broad developing directly into the two longish clasps with a broadly spatulate apex, the clasps not being separate organs jointed on to the girdle, as is usually the case, they are provided with long fine bristles. The aedoeagus is longish, very broad indeed, of almost equal width, with the orifice the full width of the tube, which is obliquely truncate at the apex; the vesica

is furnished with a central very strong spine surrounded by smaller ones in a bunch of hairs. This species I have taken out of the genus *Pentila* and made the type of the genus *Ornipholidotos*. I have selected *Pentila abraxas* for comparison with it, as it in many respects is nearer than others and is a well-known insect. The tegumen (very different from *O. muhata*) is very ample and broad with a joined apex, which is a very close approximation to the uncus of Gosse, so well known in the genus *Papilio*. It terminates in the shape of a robust horn, well excavated below, from which are developed at the rear two longish heavy lobes, which with the uncus-like extremity are furnished sparingly with fine bristles; the tergite clasps are reduced to two short strong horn-like projections well supplied with strong bristles, whilst the anal orifice opens out on to the surface in a somewhat trumpet-shaped organ. The sternite girdle is expanded backwards and is jointed on to the tergite section, which seems to form an additional covering hood over the organs just described, the sternite portion developing into a broad hollowed long groove below the sternite clasps, and expanding right in front into a heavy clubbed apex furnished plentifully with strong bristles; the clasps form part of the girdle by fusion rather than otherwise and are very broad, terminating in a longish horn strongly bristled. The aedoeagus is very long, of fairly uniform width, very highly curved; the "vas deferens" being highly developed, with the vesica very large and furnished copiously with robust curved teeth, the apical one being extra large and prominent. Here again the alliance of the two insects is evident, but the important parts of the armature from the taxonomic point of view would certainly lead us at once to look for other characters to enable us to separate them, and these we find. *Telipna acraea*—using the genus as is done by Aurivillius—is closely allied to the two species we have just considered in the development of the tergite and sternite sections, see Pl. LIX, fig. 12, but *parva* should come out of the genus. This little species is very interesting, inasmuch as it probably forms the connecting link between the *Pentila* group (in sens. strict.) and the *Liptena* group; this species, as will be seen from the figure, is without the usual form of girdle, it has none in the sternite section, it has its origin in the rear of the upper edge of the clasps with which it is fused, from whence it rises to and fuses with the tegumen, which

is a fairly simple hood excavated on the dorsum with two well-curved cheeks excised on their upper margin, at the rear of which are the robust well-curved falces; the aedoeagus is very close to *O. muhata*, short, very broad, of uniform width, with an obliquely truncated orifice; the clasps are robust, ham-shaped, with the knuckle end moderately long and deeply excised in the middle so as to be like the nose of a pair of hollowed nippers; the two clasps are joined together near the rear by a broad bridge of chitine on the upper edge, and by a narrow strong ridge on the lower margin near the rear also; this unusual method is no doubt necessitated by the fact that the girdle does not exist in the sternite.

The genus *Epitola* is seen to be rightly placed among the *Lipteninae* by the development of the girdle and the tegumen (Pl. LIX, fig. 15), by the general "build" of the clasps and markedly by the aedoeagus; if we compare this latter organ with that of *Pseuderesia tripunctata* the alliance is at once apparent, as also the form of the clasps; the prominent saccus, *i.e.* the extension rearwards at the base of the girdle, is also a somewhat important generic character. The general outline of this genus (*Pseuderesia*) and species is rather beautiful in the bold even curve of the girdle, with its broad fine lateral curtains, each fusing so neatly into the long elegant tegumen. The tegumen shows its Ruralid root in the short strong falces at the base of its small cheeks; it will be noticed that the apex of the tegumen is evenly excised to a slight extent. The girdle in this genus seems to be peculiarly strongly developed; there is an inner girdle (so to speak) consisting of a hollowed and specially strengthened "stay" extending upwards from the base to the back of the tegumen, and over this there appears to be stretched a further outer girdle fitting like a glove, fused with the tegumen and developing the delicate lateral curtains already referred to.

I have considered hitherto an ancient family, very large and predominant but not generally speaking very highly specialised, let us now examine a family that is perhaps one of the most recently specialised of groups, *viz.* the *Nymphalidae*. Take the small but widely-spread genus *Apatura* and the great genus *Charaxes*. If we look at the figure of the former (*Apatura iris*) two points will at once be evident: the form and development of the girdle with its considerable enlargement of the saccus, and also the

peculiar and prominent "uncal" projection of the tegumen with its development of a special tubular anal orifice. These are Nymphalid characteristics. Both these points are better seen in the figure of *Charaxes tiridates*, but I consider they have reached their highest stage of development in that genus, and therefore I refer to *Apatura* as the more typical; it will also be noticed that the clasps are very large. The difference between the two genera is observable at a glance; the long uncus-like tegumen with a similar but smaller formation at the base of the anal orifice, the narrow girdle with its long and narrow saccus, and the large broad and heavy clasps contrast strongly with the short tegumen of *Charaxes*, where the under projection of the anus is longer than the tegumen itself; the girdle with its very copious and long and broadish saccus and its highly receding position, whilst the clasps though large are of quite a different build to those of *Apatura*. In both the genera the aedoeagus is very long, but in *Charaxes* it is unusually long, and we find rising from the clasps a support for it to rest on which is lacking in *Apatura*.

If we compare *Limenitis* with *Neptis* the same Nymphalid characteristics are apparent, and equally good differences between the genera exist. In *Limenitis* the girdle and the tegumen are highly developed, the latter is very long and has two arms, so to speak, as an attachment to the girdle, for in this group they are not wholly fused; the lower extremity of the fore arm is the base of the anus, there being no frontal projection in these cases; the saccus is but poorly represented, whilst the clasps are very large. In *Neptis lucilla* the tegumen has a much fuller and more copious hinder formation, whilst the uncal position is much less prominent; the clasps are different and have a cleft bifid extremity almost reminding one of the *Ruralidae*. The saccus is more prominent, and the girdle is a modified formation of *Limenitis*.

In *Pararge maera* the girdle remains fairly typical and the anus still remains with a separated orifice (this marked separation is, I believe, a vestige of a very primitive character); the tegumen is very copiously developed in the rear, whilst added to the uncal apex are two small but straight spikes, almost after the manner of the *Everidae* only longer and finer but not jointed; the clasps are long and narrow with toothed and finely serrated lower edges. The aedoeagus is very small with two formidable spikes at



its lower front extremity; it is also furnished with rows of short sharp strong teeth.

*Pararge hiera* bears out entirely these differences, but the aedoeagus and the straight spikes of the tegumen differ in certain particulars, as a glance at the figures will demonstrate.

*Aphantopus hyperanthus* is thoroughly Nymphaline and shows its alliance to *Pararge* in the tegumen with its long uncus and stout straight falces (spiked hooks in the *Ruralidae*); the falces might possibly have been evolved first in this genus, inasmuch as they form a solid part of the uncus-like extremity of the tegumen, there being no joint as in *Pararge*; the clasps and aedoeagus are quite different in structure, as will be seen easily from the figure.

*Epinephele*, as shown in *jurtina*, is more advanced than any of those generally placed near it; the uncal extremity of the tegumen is exceedingly long, and the falces (these show it is rightly placed where it is) are also unusually long; the girdle and the very large clasps are of the advanced Nymphaline type; the aedoeagus, however, is of only moderate length. In addition to these there arise from the lower edge of the last tergite two quite peculiar rather long blackish barbs with deeply serrated apices, placed one on each side the girdle. I am at present unable to conjecture what their use can be.

With *Coenonympha* I will close the *Nymphalidae*, having, I hope, proved my point with the genera I have figured, and I might say I have not "selected" these. I have merely taken what I had by me and what had not to my remembrance been figured before. In *Coenonympha* the uncal extremity is even longer, proportionately, than in *Epinephele*; the falces are long and stout, very different from the fine falces of that genus; the girdle is typical of the group, but the clasps are long and narrow and are furnished with long tufts of fine hairs in addition to the ordinary hairiness of the clasps—these have been cleared away in the figure unfortunately.

In *oedippus*, the type of the genus, the uncal extremity is very large and stout, whilst the arched falces follow suit but are jointed on to the tegumen (thus approaching the articulated joints of the *Lycaenidae* only more primitive); the girdle is narrow with a short "saccus," whilst the aedoeagus is a simple tube, waved, of very moderate width and moderate length.

The *Danainae* show strong characters of their own. The genus *Danaus*, if we are to revert to Latreille's original spelling, has *phlexippus* as its type, but it is the least developed of the group in certain particulars. This we might expect from its almost world-wide distribution, and also if in it we have the origin of its family. Its Nymphaline connection is shown in the shape of the girdle and its saccus. *Danaida* has priority over *Danaus* by four years.

In *Tirumala petiverana* the tegumen is but weakly developed, that is to say, that the chitinous structure is thinner and finer than usual; the tegumen is ample and is developed at its front apex into two ears fairly well excised along the dorsal line; the girdle is copious and has a very large and prominent saccus. The aedoeagus is very large, with a sharp and highly curved downwards bend at a third from its tip, whilst at the lower margin of its tapered orifice is a very large strong tooth edged on its inner side by a short series of strong short teeth; the vesica, also large, is likewise armed with teeth and clothed heavily with fine spines; the clasps are large and highly excavated near the lower front apex and produced into a large horn extending downwards. The end segment of the abdomen proper is fairly evenly terminated without teeth or spines, but having the usual fine hairs. If we compare this with *Danaida phlexippus* we at once see strong differences, so that the armature alone at once suggests the need for another genus; the tegumen is more copious and much more developed in its fore lobes or ears as I termed them in the previous case; the girdle is stronger and the saccus changed from a very broad and large sack, to a long moderately wide cylinder; the aedoeagus, however, is totally dissimilar, it is an exceedingly long narrow tube of equal width for its entire tubular portion, and it has no spines or teeth at all, whilst the vesica has no armature at all; the clasps also have lost the formidable curved hook at their lower extremity, but have a long stout horizontal spike at their upper margin, the two spikes (*i. e.* the one on each clasp) being bridged over by a chitinous collar, whilst the whole of the sternite section is covered over by a broad apron (as it were) of chitine. The other Danaine genus I would refer to is *Amauris*. This again, from its armature only, suggests at once the necessity of dividing it off from either of the others; it has alliances to both of the preceding genera, but differs markedly from each.

The tegumen is quite different in some respects, it is much less ample, is divided into two portions, the terminal or uncal position having almost lost the bifid character; this part is developed into a small triangular hood, attached to the rear of the tegumen by a narrow ridge, and incised at its pointed extremity to a very slight extent; the formation of this has quite a different appearance to those just referred to. The girdle is slight with the saccus smaller and shorter than in *Danaida*; the aedoeagus is similar to *Tirumala* but smaller; whilst the clasps are quite solid and broad, more or less oblong, with no excrescences: in some cases they are squarish at the front edge, and in others quite rounded; the interior of the clasps is furnished with an ample supply of long strong hairs, especially at the lower margin—these hairs are present in all to some extent, but in *Amauris* they are quite a special feature. There is another quite peculiar character, the end segment of the abdomen proper is provided with a formidable series of strong sharp spines of moderate length, this feature being absent in the allied genera. It is a character that I have not found in any other of the *Rhopalocera* that I have examined. I must not omit to mention another important point, all these three genera are furnished with, viz. a pair of long brushes that are protruded from directly below the dorsum on each side of the anus. In *Tirumala* and in *Amauris* they are longish and when extended are prominent; in *Danaida* they are very much smaller, each is placed in a fine membranous case, which is turned inside out on the extrusion of the brushes. Aurivillius in Seitz's work adopts the long-overlooked name *Danaida*, and sinks both *Tirumala*, Moore, and *Melinda*, Moore, to it. I quite agree with him in thinking *Melinda* must fall to *Tirumala*, but the male armature made me at once separate *Tirumala* from *Danaida*, and I find this is borne out by the neuration, for in the primaries of Moore's genus veins 7, 8, 9 and 10 are stalked from a common base, whilst in *Danaida* 7, 8 and 9 are stalked, but 10 rises from the cell.

The valves and the peculiarly bent aedoeagus of a large number of the *Pieridae* indicate a relationship, perhaps, with the almost universal valves of the *Papilionidae*, though the organs within these valves are decidedly less complicated as a rule, whilst the entire absence of them (the valves) in some of the older families—*Colias* and *Leptidia*—to name only two, might seem to suggest that

they are not in reality closely allied, but that the more specialised genera (we cannot say dominant, for *Colias* is a decidedly dominant group), which are now so numerous, may have developed along somewhat parallel lines. Under both sets of circumstances and conditions, however, we have characters of great Taxonomic value.

If we now turn to the *Heterocera* we shall find our contention demonstrated yet more. We will go low down and examine that interesting family so long called the *Sesiidae*; the prominent character of the group is that the male armature (it is confined to the male sex) is provided with copious brushes of long hairs, fixed into the organs exactly after the manner of a hair brush except that the bristles are attached individually to the chitinous wall.

In *Trochilium apiforme*, these bristles are confined to the edges of the clasps—instead of being spread evenly over the whole inner surface—and the bristles are different; in *T. apiforme* they are long large spikes, attached directly to the chitine, not on a tubercle, constricted at the attachment, but immediately expanding very shortly and then tapering gradually to a point; they are confined to the front apical edge, and extend in considerable numbers around the fore half of the upper edge of the clasp. Another character of the group (possibly pointing to the persistence of the original type of these organs) is that the armature is practically in two sections, viz. sternite and tergite, the former being angled rearwards, whilst the latter is slightly fused on to the fore extremity of the angled apex; the tegumen thus loses the typical girdle, becoming practically a separate section (forming the anus with its own separate channel), but being just fused as already mentioned with the sternite at the one point only. In this case the tegumen is almost tubular, the apex of the dorsum being well excavated, whilst the cheeks are furnished with the spikes already referred to; below these are two prominent wedge-shaped falces. The clasps are large and broad, and are curtained over at the front apex, leaving only a deeply hollowed circle for the extrusion of the aedoeagus, which is very large; the vas deferens is densely covered with minute teeth, and the vesica furnished apparently with a rosette of the large spikes previously described. The juncture of the clasps with the girdle is very slight, again indicating the primitiveness of the structure.

These organs are very different from *Aegeria*, where we

find the separated anus has apparently disappeared, though the fusion of the tegumen, *i. e.* the tergite section, with the short girdle, *viz.* the sternite section, remains as in *Trochilium*. *Aegeria doryliformis* has quite a typical armature, and it differs so much from *T. apiformis* that the systematist would at once conclude that it must represent a different genus, and the conclusion would be borne out by further investigation. In addition to the anal orifice just mentioned, the tegumen is quite different in shape; it is deeply bifid on the dorsum, and carries on each side an extraordinary brush; it might quite well be called like—and very like—unto a carpet brush, long and tapering, with long bristles having split spatulate extremities; there is a large cavity in the tegumen within which these brushes can evidently be withdrawn, whilst at the rear of the cavity is a broad hollowed apron of chitine that would completely fit over the aperture and fall on to the front apex of the tegumen; the whole arrangement is most peculiar and wonderful. The clasps are large, wedge-shaped in this species, with the inner surfaces covered with long fine bristles with split extremities; with the exception of the lower hinder portions of the clasps, these bristles cover the whole surface. The fulcrum, in *Rhopalocera* generally only a furcate fine stem, is here developed into a broad copious hollowed support for the aedoeagus, with a fringe of formidable spike-like bristles on the upper edges of each side; this fringe is evidently capable of entire inversion in a forward direction, and might well act as an exciting agent to one or both sexes during mating. I do not know an organ to compare with this at all in other groups; the figures I give will, I hope, enable the reader to understand the action of these unusual developments. The aedoeagus is a long narrow tube very diverse from that of *T. apiforme*. The sacculus, an important character, is long and is fused with both the girdle and the clasp, the latter being rather unusual, and these organs are generally distinctly jointed on to the girdle, which is short erect but quite defined.

*Paranthrene tineiformis* again differs from *Aegeria* in very essential details; the eighth segment as in that genus is provided with great tufts of long hair in both sections of the segment, which arise from two closely tubercled cushions—two in each section. The separated anus in this genus is as marked as in *Trochilium*, though different. The tegumen has a long uncal extremity totally at variance

with the two preceding genera; the lower tubular portion is very simple, the mere tube being entirely visible in the figure (Pl. LXII, fig. 30). The clasps are bluntly ovate with long fine hairs in fair abundance, but quite different from *Aegeria*, being arranged as is generally common to these organs. The aedoeagus is long and thick, with a vesica that is heavily clothed with fine bristles. The girdle is more primitive than in *Aegeria*, whilst the saccus is almost absent.

If we compare *Orenaia* and *Titanio* we still find differences of sufficient importance to at once separate them, with the expectation of their belonging to different genera.

*Orenaia* has the tegumen—as represented by *rupestralis* and *alpestralis*—with the uncal extremity produced forwards in a long narrow horn, with a second miniature horn below it sharply serrated on its upper edge, the anal tube lying between these two horns; the tergite armature is thus complete, but it is strongly attached by a short girdle to the sternite section, which consists of clasps and aedoeagus, the former being broad, of uniform width, the apical third being densely provided with very long hairs; the aedoeagus is a long tube of even width obtusely angled at a third from the apex; the vesica is almost entirely covered with fine short teeth, which are horizontally placed as it lies at rest, but would of course be at once elevated under excitement. In *Titanio schrankiana* the tegumen becomes (by fusion) almost a part of the girdle, as it does generally in the higher orders, viz. the *Rhopalocera*; the dorsal area (of the tegumen) is broad and long with a distinct dividing line along the centre, though it is not apparently split into two divisions; the front apex being slightly incised in the centre, within the hollow thus made lies a broad horn-like structure serrated at its apex. The clasps are exceedingly broad, broad enough to envelope the whole armature, and furnished with long hairs at the apical end; the aedoeagus is a highly curved broad tube.

It will thus be seen that though the two armatures are closely allied (the insects were put in the same genus until comparatively recently), the great difference in the tegumen would at once lead one to suspect that they belonged to different genera.

The genera *Cossus* and *Duomitus* are very closely allied indeed; the tegumen in general shape and structure is quite similar; it is not tubular, but is divided into two

sections vertically, which are not separated from each other but are attached, the hind section to the short girdle and the fore section to the upper part of the clasps, and to hind section by very similar chitinous arms that hang down almost vertically, through which the anal orifice passes high up just below the dorsal plate. The sternite portions differ, however, in some important characters. The clasps in each genus are curtailed over on the fore part of the upper margin. In *Cossus cossus* the fulcrum is replaced by a large organ attached to the base of the clasp and to the juncture of the girdle and tegumen, consisting of two erect broad rounded and shagreened chitinous plates, the lower part of which is produced forwards into two long strong horns, whilst the upper part extends in a sort of chitinous muscular extension and gradually fuses with the clasp, forming a hollow resting-place for the aedocagus, which is a moderately broad somewhat curved tube of fairly even width expanding slightly towards the orifice.

In *Duomitus leuconota* the curtain of the clasps is in the rear of the upper margin, not in the forepart as in *Cossus*, and it is a fine membranous curtain, not a strongish bridge as in that genus. The organ replacing the fulcrum is a very large recurved outer tube extending well to the rear of the girdle and terminating about a third from the apex of the clasp, the front aperture being the full width of the tube; in this lies the aedocagus, which is by no means large for the size of the insect; it is ribbed for most of its length, and has a long tapered extremity. From the armature one would surmise that in both these genera we have the persistence of a primitive type of genitalia.

Turning now to the *Psychidae*, inasmuch as the females are apterous to all intents and purposes, we should expect to find that the male armature is modified, and so it is to some extent, but we find nevertheless quite decided differences between the genera. The marked character of the group is the very simple large tegumen forming a simple covering or hood over the greater part of the organs.

In *Psyche viciella*, Schiff., the hood is very large, covering about two-thirds of the segment (this does not come out adequately in the figure), the hind part of the tegumen extending on to the ventral surface; below this is a small ventral plate to which the clasps are attached; these are quite small and primitive, almost finger-shaped, but rather wider at the rear. The aedocagus is long and curved, with

a very ample vesica, that is provided copiously with fine short bristles. Comparing this with *Scioptera plumistrella* (a fairly close ally) the difference is marked; the tegumen is quite small, equally simple; the ventral plate is strongly bifid; the clasps are small, but by no means so primitive, being incised at the fore extremity into two lobes, something after the manner of the *Plebeidae*; the aedoeagus is much shorter, and much broader; the vesica must be very weakly developed as I cannot trace it in any of my preparations. In *Oreopsyche atra*, L., the tegumen is quite different in shape, being produced forwards along the middle dorsal line; it is almost double the size of *Scioptera*, though not nearly so large as in *Psyche*, being confined practically to the tergite, whilst the sternite is wholly occupied by a very large ventral plate covering the whole sternite and having a long saccus at the rear; within this lie the two clasps something similar to *Scioptera*, but with the upper lobe much produced, whilst the aedoeagus is a small simple tube. In addition to these very marked characters the seventh and eighth segments are clothed with a collar of formidable spines.

*Pachytelia unicolor* is closely allied to *Oreopsyche* as to the tegumen and ventral plate, but both are very large; the clasps are large also with apices very similar to the lobster's claw, whilst the aedoeagus is unusually large, both long and broad and with a rather extraordinary globular vesica. I would draw attention to the fact that there is no girdle in this group. It will be seen that even here where we might have looked for great modifications the armature gives very valuable Taxonomic guidance. It was necessary, of course, to confirm this by reference to other groups with what we term, somewhat loosely perhaps, apterous females, I therefore referred to *Heterogynis penella*, Hb.

In this family the tegumen is again the strongly developed portion, but here it is more than a mere covering hood; the tegumen is developed as the tegumen, but without the girdle proper, though there is what may be the first sign of it in the narrow ventral collar at the base of the tegumen. It (the tegumen) is well developed laterally and dorsally and has a peculiar uncal process that is strongly hooked, there being one strong short hook at the apex with two shorter ones at the back; the clasps appear to be absent, but I think are not so in reality, but have merely altered



their position, and in this case lie alongside the tegumen, having shifted themselves to an almost vertical position: they are two curved long broad plates and lie along the fore edge of the tegumen somewhat obliquely, forming a continuous collar with each other ventrally. The place of the clasps, however, is occupied by a finely membranous trough which apparently acts as a support for the aedoeagus, which is of an excessively fine membranous character, and were it not for the unusually large and heavily shagreened vesica, might have passed almost unobserved. I hope I have now brought forward sufficient evidence, both among the higher groups of the *Lepidoptera* as well as among the lower genera, to prove that the male armature is generally speaking of as much value in the Taxonomy as in the Phylogeny of the families. I recognise there may be cases where the value should be discounted, as there are cases of neuration where it also is at a discount; generally speaking, however, neuration is one of our most valuable characters, and inasmuch as it is present in both sexes it is a more reliable character than the male armature; but these organs will not infrequently settle a disputed point of generic affinity, as I have shown more than once in these Transactions, and the more deeply I become acquainted with them, the more am I impressed with the fact that they are of the utmost value, not only for differentiation of species but also of genera.

Whilst I am discussing the male armature I am desirous of drawing attention to a few genera of the *Ruralidae* with somewhat abnormal male organs. The smallest species of the group, omitting *Zizula gaika* perhaps, are two African and two American species, *i. e.* should the latter really prove to be distinct from each other. These must, I think, be classed under the same genus. In 1876 (Bull. Buff. Soc. iii, p. 124) Scudder proposed the name *Brephidium* for the American ones, *viz. exilis*, Boisd., and *isophthalma*, H. S. The African insects are *metophis*, Wllgr., and *barberae*, Trimen, which must certainly belong to the same genus as the others or a closely allied one, and as they have hitherto been placed in the "omnibus genera" *Lycæna* or *Cupido* I accept Scudder's name for three out of four. The male armature is on entirely similar lines, the neuration is similar and the superficial facies is likewise similar on the whole. The principal character of the armature is the enormous development of the tegumen, which occupies

two-thirds of the lateral area, and is excised along the dorsum up to the girdle or nearly up to the girdle, the lateral checks being exceedingly large and broad, their fore apex being edged with a cluster or short line of long erect formidable spines, which are carried on a long arm from the rear of the tegumen that encircles the lower and front margin, lying on it so closely as to appear to form an integral part of it; whilst there is another peculiar process in the rear of these, the clasps are pyriform in all species, and the aedoeagus in *metophis* and *exilis* is quite extraordinarily similar, but in *barberae* it differs. In the two former it is bulbous with a small curved tapering extremity at the rear and a straight narrow wedge-shaped tip, below which from near the middle of the bulb a longish narrow horn is developed with its lower apical edge serrated, this extends almost as far in front as the tip itself.

In *barberae* the aedoeagus is so totally different in shape and in most of its details, that it constrained me to think that it must belong to another though very closely allied genus. I therefore looked up its other structural characters and found they confirmed my first impressions; the neuration of the costal area is quite different from *Brephidium*. It certainly needs another genus for its reception, and I propose for *barberae* the name *Oraidium* in contrast with Scudder's name. In *Oraidium barberae* veins 6 and 7 rise from the upper apex of the cell, and 7 is not stalked, 8 and 9 are absent, 11 is bent up to almost or quite touch 12. In *Brephidium* 8 and 9 are stalked, rising from the cell well before the apex, whilst 7 is absent and 11 is a short obsolescent bar anastomosing with 12.

The armature of *Oraidium* differs in that the arms, bearing at their tips the great spines, rise from the lower front angle of the tegumen and are projected straight forward obliquely, not encircling the lateral cheeks; the aedoeagus is saddle-shaped at the rear, descending abruptly from the ridge vertically downwards, and then near the lower edge the tip is produced forwards in a very long and very narrow tube for quite double the length of its saddle portion, whilst from the lower base is projected forwards a similar equally long and yet narrower tube. The alliance of the two genera will be seen in the lower long horn-like processes which are very unusual emanating from the position of these organs. From the smallest Ruralid we will go to the largest, viz. *Liphya brassolis*, Westw.

The life-history of this extraordinarily specialised insect is now fairly well known, its entire immature life is spent in ants' nests—*Aecophilla virescens*, I believe; its larva is covered with an excessively hard chitinous coat of mail, quite impervious to the attacks of its enemies on whose larvae it feeds, and it pupates absolutely within its chitinous skin, whilst the imago when it emerges, soft and weak, is so enveloped with fugitive scales that the ants smothered with them are entirely baffled thereby. The armature is quite Ruralid but peculiarly developed; its great size will be seen from the figure which is magnified,  $\times 30$ , as are the other figures. The tegumen is not large for the size of the armature, but it has a quite peculiar hindward process; the tegumen is continued to the rear for two-thirds of its forward length, two longish crescentic arms then descend, which are entirely excavated on their inner side, giving the appearance of a great hooked extension at the back of the girdle, there are the usual falces of the order, large and strong; the girdle is copious but simple, and the clasps are small, ham-shaped, with the knuckle end (*i. e.* the apex) well furnished with strong short teeth; the fulcrum is very strong, rising from two pyramidal bases with a common foundation, and consist of two erect strong straight spikes; the aedoeagus is a large and broadish tube, with the usual basal extension and a large shagreened vesica, which is seen in the figure as apparently part of the apical orifice of the tube.

In the genus *Mimacraea* we might perhaps expect to find, as we do, very specialised armature, the short anal orifice (or very short tube) is apparent practically on the underside of the dorsum, there being no tegumen proper (as to its dorsum at least), the anus taking its place and being fused on to the two lateral lobes or cheeks of the tegumen at their upper rear margin: the lateral part of the tegumen consists of two large spherical lobes (one on each side) whose upper front margin is produced forwards into two long curved horn-like processes, the apices of which have a short row of very fine minute setae. The girdle is narrow and simple in its main support, but is provided with fine lateral curtains from the base of the tegumen to near the fore part of the clasps; this curtain is furnished with strong spines on its lower portion, as also is the inner surface of the clasps; these are of unusual shape, difficult to describe, and are furnished at the ex-

tremity with a stout downward curved hook; the fulcrum is absent doubtless because the very unusual shape of the aedoeagus would render it useless unless it were enormously developed. The aedoeagus is angled sharply near its rather ample base at right angles, where it ascends and in a deep bold curve is then bent over and produced forwards as a long strong tapering horn and terminates in a pointed tip.

The only genus with which I am yet acquainted that has any resemblance in its tegumen to *Mimacraea* is *Arrugia*; in *basuta* the tegumen somewhat approaches the shape of its lateral lobes but is very dissimilar in its other parts; its fore lobes are somewhat like those just described, but the rear portion of the tegumen is normally constructed, being entirely hooded over. In this genus, however, the tergite and sternite have their own organs; beneath the lobes at their inner extremity the faeces rise and are two powerful horns deeply curved, whilst directly below them, more or less parallel as to position, are a pair of shorter curved arms edged on the upper margin with short sharp teeth, these form the lower margin of the tergite section. The clasps are large and broad, roughly Plebeid in shape, but without the apical incision; the fulcrum is long straight and oblique; the aedoeagus is a shortish broad tube straight on its upper margin, waved on its lower margin, slightly tapered at its apex, with a finely shagreened vesica; there is a broad collar fixed in the girdle through which it passes; the girdle is very narrow and irregular with fine lateral curtains and with a prominent saccus. It will thus be seen that whilst the armature points to a strong Liptenine origin there is yet something apparent in the clasps and saccus of a Ruraline character.

The American *Fenisca tarquinia*, as also the Eastern *Spalgis epius*, have carnivorous larvae and peculiar facies of their own, both however have Ruralid armature, though developed on lines of their own in some respects.

*Fenisca tarquinius*, Fab. (Pl. LXV, fig. 46).

This has the tegumen hooded and strongly developed forwards, its front apex having a slight rounded excavation; it has the usual faeces; the clasps are subtriangular and are bridged over by a narrow elevated chitinous collar from the apex of the triangle; the front tip is strongly

but very shortly toothed. The aedoeagus is very long, narrowish with the apex finely toothed; the girdle is fairly ample, erect with a very long narrow saccus. It very frequently follows that a very long aedoeagus is accompanied by a very long saccus.

*Spalgis epius*, Westw. (Pl. LXV, fig. 47).

Here the tegumen is also hooded, but quite differently from *Fenisca*; it forms a distinct hood, being only slightly attached to the girdle at the rear of the dorsum, the development is entirely forwards again; the falces are quite short and broad; the clasps are subovate with constricted and hollowed and toothed fore edges; two strong deeply curved horns drop forwards from near the centre of the clasps which may possibly take the place of the fulcrum, it is, however, an unusual formation; the girdle is fairly erect but curved in the middle, and is without any saccus; the aedoeagus is longish with the tube tapering somewhat smaller for its apical half.

In closing I will compare two genera somewhat widely separated, viz. *Horaga* type *onyx* and *Loxura* type *atymnus*, in order to show a somewhat unusual development in each case, but a development that has gone on along parallel lines, though the genera are not at all closely related. It is not, of course, surprising that this should be so, but it is none the less interesting.

In *Horaga onyx* the tegumen consists of a saddle which is very deeply bifid, the two extremities being hoof shaped; the falces are attached at the back and on to (as it were) the fetlock joint; the girdle is broad, inclined well forwards and has no saccus, whilst the clasps are scymitar shaped, with an abundant supply of long coarse bristles. The aedoeagus is of moderate size, both as to length and width, with the vesica highly developed, being covered with short teeth.

In *Loxura atymnus* the tegumen has the saddle ridge much reduced, whilst the highly bifid extremities are decidedly increased in length, terminating in two finger-like appendages; the falces are long and fine and deeply curved; the girdle is very broad and ample, very much depressed and inclined forwards and over the clasps; the knife-shaped clasps, have the basal half decidedly wider than the fore part, there are no long bristles, but instead the edges of the clasps have a few very short fine

hairs; the aedoeagus is wide at its basal attachment, but the fore half is a simple narrow tube with the vesica scarcely developed at all. It will thus be seen that the clasping and general armature of the two genera has developed along closely similar lines.

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EXPLANATION OF PLATES LV-LXV.

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PLATE LV.

- No. 1. *Plebeius argus*  $\times$  30.  
 2. *Polyommatus icarus*  $\times$  30.  
 5. *Hypaurotis chrysalis*  $\times$  20.  
 5a. *Hypaurotis chrysalis*  $\times$  30 (to show the formation of the tegumen and falces and the aedocagus).

PLATE LVI.

- No. 3. *Neolycaena tengstroemi*.  
 4. *Habrotis grunus*.  
 6. *Ialmenus evagorus*.  
 7. *Pseudalmenus myrsilus* (fulcrum accidentally eversed).

All magnified  $\times$  30.

PLATE LVII.

- No. 8. *Gerydos leos*  $\times$  30.

PLATE LVIII.

- No. 9. *Megalopalpus gigas*  $\times$  15.  
 9a. *Megalopalpus gigas*  $\times$  15 (to show the wide angle of vertical motion).  
 10. *Ornipholidotos mukata*  $\times$  30.  
 11. *Pentila abraxas*  $\times$  30.

PLATE LIX.

- No. 12. *Teliþma acraea*.  
 13. *Liptena parva*.  
 14. *Pseuderesia tripunctata*.  
 15. *Epitola posthumus*.

All magnified  $\times$  30.

## PLATE LX.

- No. 16. *Apatura iris* × 10.  
 17. *Charaxes tiridates* × 6.  
 18. *Limenitis camilla* × 10.  
 19. *Neptis lucilla* × 10.  
 20. *Pararge maera* × 10.  
 21. *Epinephele jurtina* × 10.

## PLATE LXI.

- No. 22. *Aphantopus hyperantus* × 10.  
 23. *Coenonympha oedippus* × 20.  
 24. *Danaida phlexippus* × 6.  
 25. *Tirumala petiverana* × 6.  
 26. *Amauris dannfeldti* × 6.  
 27. *Amauris angola* × 6.

## PLATE LXII.

- No. 28. *Trochilium apiformis* × 15.  
 29. *Aegeria doriliformis* × 30.  
 30. *Paranthrene tineiformis* × 30.  
 31. *Orenaia rupestralis* × 30.  
 32. *Titanio schrankiana* × 30.  
 33. *Cossus cossus* × 10.  
 34. *Duomitus leuconota* × 10.

## PLATE LXIII.

- No. 35. *Psyche viciella* × 30.  
 36. *Scioptera plumistrella* × 30.  
 37. *Oreopsyche atra* × 30.  
 38. *Pachytelia unicolor* × 30.  
 39. *Heterogynis penella* × 30.  
 40. *Brephidium exilis* × 30.  
 41. *Oraidium barberae* × 30.  
 44. *Mimacraea fulvaria* × 10.

## PLATE LXIV.

- No. 42. *Liphyra brassolis* × 30

PLATE LXV.

- No. 45. *Arrugia basuta* × 20.  
46. *Fenisca tarquinnius* × 30.  
47. *Spalgis epius* × 30.  
48. *Horaga onyx* × 30.  
49. *Loxura atymnus* × 30.



*Revision of the Mexican and Central American Chaulio-  
gnathinae (Fam. Telephoridae), based on the genital  
armature of the males: a correction.* By GEORGE  
CHARLES CHAMPION, F.Z.S.

Too late for correction in the proper place, a mistake has been detected in the name of one of the species of *Chaulio-  
gnathus* figured in the "Revision" (*antea*, pp. 128-168), due to the printed label-number, 1665, attached to the separately-mounted preparation having been misread 1655. The dissection (1665) of a dark variety of *C. limbicollis* was thus, by accident, selected for the figure (Plate V, figs. 14, 14a) and description (p. 144) of the aedeagus of the male of *C. lecontei*; the corresponding structure of the first-named insect was correctly illustrated on Plate VI, figs. 22, 22a. Figures of the aedeagus of *C. lecontei* are appended herewith, and the following description must replace that given on p. 144. As might be expected, the general structure of the organ in question is very similar to that of the allied *C. profundus*, except that the left lateral lobe is very much shorter.

*C. lecontei*, Ch. ♂. Aedeagus: median lobe stout, strongly curved, produced at the apex into a broad, spoon-shaped process; left lateral lobe moderately long, stout, angulate at about the middle, the basal portion broad, the apical portion narrower, spoon-shaped, abruptly hooked at the tip; right lateral lobe much shorter than the left, compressed, obliquely bent outwards from about the middle, the tip somewhat pointed.



*C. lecontei*, Ch.

OCTOBER 8TH, 1914.